Amendments to the Specification:

On page 1, paragraph 1:

This application is a divisional of U.S. Serial No. 09/924,392, filed August 7, 2001, which application claims the benefit of U.S. provisional application serial number 60/223,874, filed August 8, 2000 ~~which is~~ both of which are fully incorporated herein by reference.

On page 10, paragraph 2 through page 11, paragraph 2:

Photonic device 10 can have at least one spacer layer 18 between two adjacent repeating units 14. Additionally, a spacer layer 18 can be positioned between more than one pair of adjacent repeating units 14, including all adjacent repeating units 14. The spacer layer is used to improve the structural quality, symmetry, optical quality, or electronic quality of the superalattice. Additionally, superlattice 11 can be positioned or grown on a substrate 20, including but not limited to a silicon substrate, or on a pseudo-substrate buffer layer ~~22~~ that has a lattice constant which is different from a lattice constant of a bulk silicon substrate. Where a psuedo substrate is defined as thick layer with low defect surface density that is grown over the substrate.

In one specific embodiment, superlattice 11 is grown on silicon substrate 20 along (001)- and (111), (211), (311), (411) and the like growth directions of the silicon substrate 20. The growth of the lattice matched and/or lattice mismatched layers 12 can be epitaxially grown on silicon substrate 20 or on a pseudo substrate ~~22~~ that can be a bulk or superlattice strained, or relaxed buffer layer. Figures 2(b) illustrates superlattice 11 growth in the (111) direction. Figure 2(c) illustrates an in-plane erbium/silicon active layer crystal structure without defects grown on a (111)-orientated surface.

In various embodiments, active region layer 16 has a lattice layer that is less than, the same as or equal to a lattice constant of silicon substrate 20 or pseudo-substrate buffer layer ~~22~~. It may be preferred for active region layer 16 containing the rare-earth atoms to be in a mechanically stressed state when grown epitaxially on silicon substrate 20 or pseudo substrate ~~22~~ by either tension, lattice mismatching or compression. This reduces the defect density which in turn improves structural quality.

In certain embodiments, at least one layer in a repeating unit 14 has a lattice constant that is sufficiently different from, (i) a lattice constant of substrate 20 to have an opposite

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state of mechanical stress or (ii) a lattice constant of pseudo-substrate buffer layer ~~22~~ to have an opposite state of mechanical stress. In one embodiment, at least two layers 12 of repeating units 14 have substantially equal and opposite mechanical strain states and, (i) each repeating unit 14 is substantially lattice matched to substrate 20 or (ii) each repeating unit 14 is substantially lattice matched to pseudo-substrate buffer layer ~~22~~. Additionally, the crystal field of the superlattice can be modified by a strain field induced by lattice mismatched layers in a repeating unit.

On page 17, paragraph 1 through page 18, paragraph 2:

Referring now to Figure 7, the present invention is also an optical receiver 48 where photons are converted into electrons. Optical receiver includes superlattice 11 positioned between a p-doped layer 50 and an n-doped layer 52 which can both be made substantially of silicon. Electrodes 54 and 56 are coupled to p-doped layer 50 and n-doped layer 52. Electrodes 54 and 56, in combination with other circuit elements, provide biasing, small-signal amplification and noise filtering. Superlattice 11 can be integrally formed with substrate 20 or pseudo substrate ~~22~~. Additional elements can be integrated with substrate 20 or pseudo substrate ~~22~~. This level of integration enables optimum speed and minimal noise, giving the best signal to noise ratio and excellent detection characteristics. The present invention is also a tunable or non- laser such as an edge emitting laser 58 of Figure 8 or a VCSEL 60 of Figure 9.

Edge emitting laser 58 includes superlattice 11 in the plane of substrate 20 or pseudo-substrate ~~22~~. Edge-emitting laser 58 includes electrodes to excite superlattice 11, lower and upper optical waveguide cladding layers, a high mobility silicon layer used for electronic transistor construction, n-type well field effect transistors (FET), a field effect, gate oxide layer, a silicon oxide isolation layer, and lateral oxidation of silicon layers that are used for electronic and superlattice 11 isolation.

With VCSEL 60, light travels in superlattice 11 orthogonal to the plane of substrate 20 or pseudo substrate ~~22~~. First and second mirrors 62 and 64 define a resonant cavity. VCSEL 60 includes electrodes to excite superlattice 11, lower and upper optical waveguide cladding layers, a high mobility silicon layer used for electronic transistor construction, n-type well field effect transistors (FET), a field effect, gate oxide layer, a silicon oxide isolation layer, lateral oxidation of silicon layers that are used for electronic and superlattice 11 isolation, and a micromachines silicon micro-lens array in substrate 20.

Reflectors 62 and 64 can be grown as Bragg gratings, or produced by cleaving facets

on the ends of substrate 20 or pseudo-substrate ~~22~~. This cleaving process is described in U.S. No. 5,719, 077, incorporated herein by reference. The output wavelength of the lasers 58 and 60 can be tuned by varying the repeating unit 14 of superlattice 11, which changes the crystal field and hence the transition energy of the laser transition. Bragg elements Acting either as an integral cavity mirror or external feedback element, can be fabricated at the output end of lasers 58 and 60 to provide feedback which limits and controls linewidth. Tuning and bandwidth can be controlled by varying period of repeating unit 14.

Figure 8 illustrates one embodiment of the integration of a rare-earth crystal field superlattice 11 grown epitaxially on substrate 20 and pseudo-substrate ~~22~~. Following the completion of superlattice 11 a spacer layer 65 is grown to isolate a high mobility silicon layer that is suitable for Si CMOS VLSI. This example of an MBE grown epitaxial compound silicon-based substrate 20 or pseudo-substrate ~~22~~ can then be processed to form ion-implantation doped regions, electrical contacts to the doped ion-implanted regions , silicon oxide field effect gate regions and dielectric isolation regions.

On page 19, paragraph 1:

The optical waveguide mode can be confined in the core region by appropriate growth of suitable lower cladding material. This can be achieved for the core and cladding layers by selectively altering the layer refractive index via impurity doping; or via the use of silicon germanium alloys or the use of silicon oxide buried layers. The latter example, can be implemented for the lower cladding oxide layers using epi-ready separation by oxygen implantation (SIMOX) silicon wafers, silicon-on-insulator (SOI) or silicon-on-sapphire (SOS) starting substrates 20 or pseudo-substrates ~~22~~.

On page 20, paragraph 1:

The period of repeating unit 14 can be chirped across substrate 20 or pseudo substrate ~~22~~ as shown in Figure 10. This provides a controlled variation of wavelength based on the position on substrate 20 or pseudo substrate ~~22~~. The crystal field varies with physical period and composition of the superlattice, thus varying the period in a continuous fashion (i.e., chirp) causes a continuous shift in crystal field and therefore laser output wavelength. Multiple lasers with different wavelengths, separated by discrete steps, can be produced on a single substrate 20 or pseudo substrate ~~22~~. This provides discrete step tuning from a single component with internal circuitry simply by electronic selection of the appropriate wavelength laser. that can be created on the same substrate 20 or pseudo substrate ~~22~~ using

standard VLSI techniques. In this manner, lasers 58 and 60, and their electronic switching fabric, reside on the a single substrate 20 or pseudo substrate ~~22~~. The appropriate laser wavelength is then selected by electrical input signals which on-board chip components decode, or by simple external wiring which can be grown as selective area growth MOCVD. With this concept, superlattice 11 can be initially grown as a structure that changes its layer 12 thickness uniformly across a cross-sectional area. This is useful for a transmitter in a DWDM system.

On page 20, paragraph 3 to page 21, paragraph 1:

Referring now to Figure 12, optical receiver 48 can be combined with laser 58 or 60 on the same substrate 20 or pseudo substrate ~~22~~ to form a monolithic transceiver 66. Circuitry 68 is also fabricated on the same substrate 20 or pseudo substrate. Circuitry 68 can include an electrical amplifier, signal processor, diode laser driver and the like. Circuitry 68 can be used to, bias optical receiver 48 and lasers 58, 60, amplify the photons detected by optical receiver 48, drive and modulate laser 58 and 60, and the like. Circuitry 68 enables conversion of photons into electrons and enable electrons to drive and modulate laser 58 and 60. Monolithic transceiver 66 can be used to replace the discrete elements in a standard telecommunications router.

In another embodiment, illustrated in Figure 13, a monolithic optical router 70 includes a plurality of lasers 58 and 60 and a plurality of optical receivers 48 all combined on a single substrate 20 or pseudo substrate ~~22~~ with circuitry 72. Circuitry 72 biases the plurality of lasers 58 and 60 and optical receivers 48 to amplify the photons that are detected and then drive and modulate the plurality of lasers 58 and 60. An additional set of circuit elements forms an electrical switching fabric 74 that enables signals generated by one or more of the optical receivers 48 to be routed to any laser 58 and 60. Monolithic optical router 70 enables optical signals on any one of an input to be switched to any one of the outputs.

On page 24, paragraph 1:

Alternatively, as shown in Figure 18, the present invention is also a two-dimensional photonic bandgap (2D-PBG) structure 94 implanted in the output path of the input beam or waveguide Bandgap structure 94 includes superlattice 11 with periodic variation, and repeating units 14 of bandgap structure 94 are selected to optimize the diffraction of light. Bandgap structure 94 consists of an array of predominately cylindrical ion-implantation disordering doped or physically etched regions either within or external to the superlattice.

orthogonal to the plane of substrate 20 or pseudo substrate ~~22~~ which act as a diffraction grating.

On page 24, paragraph 3:

In another embodiment, illustrated in Figure 19, the present invention is a selectable wavelength add/drop multiplexer 96 that has a concentric ring waveguide 98 fabricated in substrate 20 or pseudo-substrate ~~22~~ to form a "Light Coral" of the type described by Nanovation, "The Micro revolution", Technology Review" July-August 2000, incorporated herein by reference, in which light of a frequency resonant with ring waveguide 98 is selectively coupled out of one vertical waveguide . and into the other vertical waveguide, via ring waveguide 98 which includes a superlattice 11 with optical gain/loss device 24 to enhances or suppress the wavelength coupled into ring waveguide 98. The addition of optical gain/loss device 24 makes ring waveguide 98 act as selectable wavelength add/drop multiplexer 96.